REL SOUTHWEST Regional Educational Laboratory Southwest

REL Southwest Ask A REL Response

June 2020

Question:

What is the evidence on the relationship between students participating in CTE/ STEM pathways programs and high school and postsecondary outcomes?

Response:

Thank you for the question you submitted to our REL Reference Desk. We have prepared the following memo with research references to help answer your question. For each reference, we provide an abstract, excerpt, or summary written by the study's author or publisher. Following an established Regional Educational Laboratory (REL) Southwest research protocol, we conducted a search for research on the relationship between students participating in career and technical education (CTE)/science, technology, engineering, & mathematics (STEM) pathways programs and high school and postsecondary outcomes.

We have not evaluated the quality of references and the resources provided in this response. We offer them only for your reference. Also, we searched the references in the response from the most commonly used resources of research, but they are not comprehensive, and other relevant references and resources may exist. References provided are listed in alphabetical order, not necessarily in order of relevance. We do not include sources that are not freely available to the requestor.

Research References

Cole, B., High, K., & Weinland, K. (2013). High school pre-engineering programs: Do they contribute to college retention? *American Journal of Engineering Education, 4*(1), 85–98. https://eric.ed.gov/?id=EJ1057111

From the ERIC abstract: "The study examines the retention of students in the College of Engineering, Architecture and Technology at Oklahoma State University that enter college with a defined course sequence in a pre-engineering program from a regional career technology center as compared with the retention rates of university engineering students for the same time period. In addition to descriptive data, results from one-sample tests that compared the homogeneity of proportions in enrollment across semesters completed between the groups are presented. The results of this foundational study suggest similar rates of persistence in the College of Engineering, Architecture and Technology among Oklahoma regional technology center pre-engineering program students entering college and those entering with more traditional high school academic preparation."

Denson, C. D. (2017). The MESA study. *Journal of Technology Education, 29*(1), 66–94. https://eric.ed.gov/?id=EJ1164712

From the ERIC abstract: "This article examines the Mathematics, Engineering, Science Achievement (MESA) program and investigates its impact on underrepresented student populations. MESA was started in California during the 1970s to provide pathways to science, technology, engineering, and mathematics careers for underrepresented students and represents an exemplar model of informal learning environments. Using a mixed-method research design of investigation, this exploratory study looks at the relationship between MESA activities and underrepresented students' self-efficacy, interests, and perceptions related to engineering. Evidences for this study includes data from focus-group interviews conducted and results from quantitative data collected using the Engineering, Self-Efficacy, Interests, and Perceptions Survey (ESIPS) instrument. Results from this study suggest that participation in MESA's activities has a positive influence on underrepresented students' self-efficacy, interests, and perceptions related to engineering."

Dixon, R. A., & Brown, R. A. (2012). Transfer of learning: Connecting concepts during problem solving. *Journal of Technology Education, 24*(1), 2–17. https://eric.ed.gov/?id=EJ991236

From the ERIC abstract: "A concern of many educators and managers is students' ability to transfer concepts and procedures learned in school to the work environment. When children are taught a skill, such as solving a mathematical problem, they often fail to recognize that their new skill can be used to solve a similar problem outside of school. In other cases, students who are skilled with certain tasks outside of school often have difficulty transferring concepts learned from these experiences to the solving of well-structured problems in schools, such as those often found on mathematics and science tests. These findings demonstrate the inability of students to recognize the transferability of concepts learned from solving well-structured problems in the classroom to ill-structured problems faced outside of the classroom and also the transferability of concepts learned from solving ill-structured problems, similar to those encountered in the real world, to the solving of well-structured problems encountered in the classroom. Various curricula and outreach programs, such as Design, Technology, and Engineering for All Children, Engineering by Design[TM], Project Lead the Way, Engineering is Elementary[R], LEGO[R] Engineering, and others, offer various types of problem-based and project-based experiences, which engage students in authentic problem solving. These learning initiatives help to improve students' ability to transfer knowledge, concepts, and skills learned in schools to real-life contexts. This study focuses on one such curriculum—Project Lead the Way (PLTW)—a multi-year, problem-based/project-based pre-engineering curriculum that is used by some schools in their engineering and technology education program. Since a large portion of the PLTW objectives emphasize content from mathematics and/or science standards, it is the authors' view that students should be able to demonstrate the ability to connect concepts learned from engaging in PLTW curriculum activities to the solving of mathematics and science test problems in the classroom. The purpose of this study is to determine if PLTW students are able to better transfer mathematics, science, and design concepts from one situation to another than students who have not taken the PLTW courses and the extent to which students are

able to make connections to concepts learned in the PLTW courses to concepts that they are required to use when solving standardized test problems. The authors found significant relationships between the number of PLTW courses students took and students' performance in design score and total score. Also, there was no significant difference in mathematics and science performance between PLTW and non-PLTW students. PLTW students, however, performed significantly better on the design component of the test."

Erdogan, N., & Stuessy, C. (2016). Examining the role of inclusive STEM schools in the college and career readiness of students in the United States: A multi-group analysis on the outcome of student achievement. *Educational Sciences: Theory and Practice, 15*(6), 1517–1529. https://eric.ed.gov/?id=EJ1101328

From the ERIC abstract: "The most prominent option for finding a solution to the shortage of workers with STEM knowledge has been identified as specialized STEM schools by policymakers in the United States. The current perception of specialized STEM schools can be described as a unique environment that includes advanced curriculum, expert teachers, and opportunities for internships and immersion. This study highlights the college readiness of STEM school graduates in comparison with traditional high school graduates. Using 11th grade students' high-stake test results in reading, mathematics, and science, this article compares the achievement outcomes of both school types. In answering the research questions related to student success for attendees of either STEM or traditional schools, this research concluded that success with reading, mathematics, and science high-stake tests for students does not differ by school type. However, student demographic variables (gender, ethnicity, socioeconomic status, and special education status) may influence the success of students attending STEM schools. For example, the results revealed a statistical significance between the reading, mathematics, and science scores of male, Hispanic, White, and economically disadvantaged students from STEM and traditional schools."

Fletcher, E. C. Jr., & Tyson, W. (2017). Bridging technical skills gaps between high school students and local employers. *Journal of Research in Technical Careers, 1*(1), 20–31. https://eric.ed.gov/?id=EJ1245771

From the ERIC abstract: "The purpose of this study was to explore how technical skills taught and learned in Florida engineering and engineering technology-themed career academies fit technical skills desired by local employers in technology and manufacturing. The analysis utilized the narratives of 70 students and four teachers from career academies at four high schools and 27 industry leaders from the same geographical region of Florida. Data interpretation led to understanding that employers expressed an urgent need for technical skills using appropriate equipment and technologies, teachers were teaching students technical skills by simulating the real-world work environment, and students valued their abilities to transform their classroom project ideas into tangible products."

Gonzales, A., Jones, D., & Ruiz, A. (2014). Toward achievement in the "knowledge economy" of the 21st century: Preparing students through T-STEM academies. *Research in Higher Education Journal, 25*(1), 1–14. https://eric.ed.gov/?id=EJ1055333

From the ERIC abstract: "Schools are constantly engaged in implementing reform strategies to prepare students for postsecondary education leading to their career choices. Challenges here involve education initiatives addressing programs not strategically planned, educators not prepared for transition, and no follow-up support beyond initial implementation stages. This study examined school reform initiatives by the Texas Science, Technology, Engineering, and Math academies toward better-quality instruction, to prepare students for post-secondary education, and in-turn, for the knowledge economy of the 21st century. The purpose of the study was to gauge the effectiveness of these academies in math, science, and engineering, and if these academies are successful educational-reform systems. Inductive data analysis was conducted from general program data and teacher interviews from one rural and one urban high school. Data were obtained through observations, interviews, and program documents. The coding system subdivided the data into domains to establish semantic relationship, and to uncover frames within the data. Terms under each domain served as parameters for each respective domain. The practice of member-checking, peer debriefing, and data triangulation ensured validity, and case study protocols established reliability of results. Results indicated that T-STEM academies have implemented educational reform strategies that produce better-prepared graduates for post-secondary education and perhaps students that are prepared for the knowledge economy. Implications of the study for social change include heighten awareness of effective instructional practices to increase student achievement, as well as contribute to future STEM development relative to economic trends."

Means, B., Wang, H., Wei, X., Iwatani, E., & Peters, V. (2018). Broadening participation in STEM college majors: Effects of attending a STEM-focused high school. *AERA Open, 4*(4), 1–17. https://eric.ed.gov/?id=EJ1201171

From the ERIC abstract: "To increase participation in science, technology, engineering, and mathematics (STEM) studies and careers, some states have promoted inclusive STEM high schools. This study addressed the question of whether these high schools improve the odds that their graduates will pursue a STEM major in college. State higher education records were obtained for students surveyed as seniors in 23 inclusive STEM high schools and 19 comparison schools without a STEM focus. Propensity score weighting was used to ensure that students in the comparison school sample were very similar to those in the inclusive STEM school sample in terms of demographic characteristics and Grade 8 achievement. Students overall and from under-represented groups who had attended inclusive STEM high schools were significantly more likely to be in a STEM bachelor's degree program two years after high school graduation. For students who entered two-year colleges, on the other hand, attending an inclusive STEM high school was not associated with entry into STEM majors."

National Research Council. (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics*. Washington, DC: The National Academies Press. https://eric.ed.gov/?id=ED536475. Retrieved from https://www.nap.edu/read/13158/chapter/1

From the ERIC abstract: "Science, technology, engineering, and mathematics (STEM) are cultural achievements that reflect our humanity, power our economy, and constitute fundamental aspects of our lives as citizens, consumers, parents, and members of the workforce. Providing all students with access to quality education in the STEM disciplines is important to our nation's competitiveness. However, it is challenging to identify the most successful schools and approaches in the STEM disciplines because success is defined in many ways and can occur in many different types of schools and settings. In addition, it is difficult to determine whether the success of a school's students is caused by actions the school takes or simply related to the population of students in the school. 'Successful K-12 STEM Education' defines a framework for understanding 'success' in K-12 STEM education. The book focuses its analysis on the science and mathematics parts of STEM and outlines criteria for identifying effective STEM schools and programs. Because a school's success should be defined by and measured relative to its goals, the book identifies three important goals that share certain elements, including learning STEM content and practices, developing positive dispositions toward STEM, and preparing students to be lifelong learners. A successful STEM program would increase the number of students who ultimately pursue advanced degrees and careers in STEM fields, enhance the STEM-capable workforce, and boost STEM literacy for all students. It is also critical to broaden the participation of women and minorities in STEM fields. 'Successful K-12 STEM Education' examines the vast landscape of K-12 STEM education by considering different school models, highlighting research on effective STEM education practices, and identifying some conditions that promote and limit school- and student-level success in STEM. The book also looks at where further work is needed to develop appropriate data sources. The book will serve as a guide to policy makers; decision makers at the school and district levels; local, state, and federal government agencies; curriculum developers; educators; and parent and education advocacy groups."

Proudfoot, D. E., Green, M., Otter, J. W., & Cook, D. L. (2018). STEM certification in Georgia's schools: A causal comparative study using the Georgia Student Growth Model. *Georgia Educational Researcher, 15*(1), 16–39. https://eric.ed.gov/?id=EJ1194612

From the ERIC abstract: "The increase in demand for college and career ready students has driven the need for education reform to ensure K-12 schools can support student learning across all content areas and grade levels. A STEM Certification process was established by the Georgia Department of Education as part of an effort to reform public school STEM education. Additionally, an international STEM Certification procedure developed by AdvancED has been implemented in several Georgia schools. As a significant component of STEM certification guidelines, problem based learning has been incorporated to stimulate student interest in science, facilitate self-regulation, and increase pedagogical and content knowledge. As Georgia schools become STEM certified, it is important to understand how certification has influenced achievement in

math and science as well as important non-STEM disciplines such as English language arts and social studies. This causal comparative study examined if the STEM certification process altered student achievement in participating schools as compared to schools that have not participated. Student achievement was measured by the median growth percentiles (MGPs) between STEM certified and non-STEM schools in the content areas of English language arts, mathematics, science, and social studies at the fourth and fifth grade levels using a Mann-Whitney U test. The study found only the MGPs for fourth grade ELA were significantly higher ($p = 0.004$) in STEM certified schools. Overall, inconsistent differences in MGPs for ELA, math, science, and social studies were found between STEM certified and non-STEM schools."

Ruth, A., Hackman, J., Brewis, A., Spence, T., Luchmun, R., Velez, J., et al. (2019). Engineering Projects in Community Service (EPICS) in high schools: Subtle but potentially important student gains detected from human-centered curriculum design. *Education Sciences, 9*(1), 1–17. https://eric.ed.gov/?id=EJ1211950

From the ERIC abstract: "A major goal in Engineering training in the U.S. is to continue to both grow and diversify the field. Project- and service-based forms of experiential, problem-based learning are often implemented with this as a goal, and Engineering Projects in Community Service (EPICS) High is one of the more well-regarded and widely implemented. Yet, the evidence based on if and how participation in such programs shapes student intentions and commitment to STEM pathways is currently limited, most especially for pre-college programming. This study asks: How do high school students' engineering mindsets and their views of engineering/engineers change as they participate in project-service learning (as implemented through an EPICS High curriculum)? This study employed a mixed method design, combining pre- and post-test survey data that were collected from 259 matched students (63% minority, 43% women) enrolling in EPICS High (total of 536 completed pre-tests, 375 completed post-tests) alongside systematic ethnographic analysis of participant observation data conducted in the same 13 socioeconomically diverse schools over a two-year period. Statistical analyses showed that participants score highly on engineering-related concepts and attitudes at both pre- and post-test. These did not change significantly as a result of participation. However, we detected nuanced but potentially important changes in student perspectives and meaning, such as shifting perceptions of engineering and gaining key transversal skills. The value of participation to participants was connected to changes in the meaning of commitments to pursue engineering/STEM."

Sublett, C., & Plasman, J. S. (2017). How does applied STEM coursework relate to mathematics and science self-efficacy among high school students? Evidence from a national sample. *Journal of Career and Technical Education, 32*(1), 29–50. https://eric.ed.gov/?id=EJ1167165

From the ERIC abstract: "Over the past decade, CTE has been highlighted as a means of promoting college and career readiness for high school students. Applied STEM coursework is a promising area of high school study that has particular relevance in the technologically progressive world of today. Previous research has illustrated that applied STEM coursework in high school is associated with a number of positive educational

outcomes. Importantly, no previous empirical investigation has examined the relationship between applied STEM coursework and students' reported levels of math and science self-efficacy, two important harbingers of academic ability and success. Consequently, the current study used nationally representative data to explore applied STEM coursework participation and self-efficacy. Results indicated that applied STEM coursework was predictive of increases in both math and science self-efficacy, except among females and students with disabilities (SWDs). Implications for policy are discussed."

Wang, H., Means, B., Young, V., & House, A. (2018, March). *A longitudinal study of the impact of attending an inclusive STEM high school: The case for using two comparison groups.* Paper presented at the Society for Research on Educational Effectiveness Spring 2018 Conference, Washington, DC. https://eric.ed.gov/?id=ED591587

From the ERIC abstract: "Policymakers argue that only by enlarging the science, technology, engineering, and mathematics (STEM) pipeline in a way that attracts, supports, and sustains the participation of students from all kinds of backgrounds can the United States meet its needs for science and technology innovation, economic prosperity, and social well-being (National Academies, 2005). To meet this need, inclusive STEM high schools (ISHSs) combine rich STEM course offerings and experiences with an explicit mission to serve students from under-represented groups accepted on the basis of interest rather than competitive examination. One of the distinctive features of the present ISHS study is that it provides a comprehensive picture of the impact of ISHSs by using two sets of comparison groups: schools in the same districts as the ISHSs to control for local context; and comparable schools in districts with no access to STEM schools to alleviate potential bias caused by student self-selection into ISHSs. The two comparisons validate each other in providing solid evidence regarding the impact of ISHSs. This study addresses the following research questions: (1) Do students attending ISHSs differ from students in other same-district high schools in terms of demographic characteristics and middle school achievement? and (2) Is there evidence of an impact of ISHS attendance on students' persistence to 12th grade, high school graduation, and college readiness and aspirations? The data indicates that North Carolina ISHSs served a diverse set of students. Compared with students in the same districts, ISHS students had slightly lower incoming academic achievement and were more likely to be African American and to come from low-income households. Within- and out-of-district comparisons provide consistent findings on the impact of ISHS attendance. ISHS attendance appears to have a positive impact on students' persistence to 12th grade, high school graduation, and college readiness and aspirations."

Zarske, M. S., Yowell, J. L., Ringer, H. L., Sullivan, J. F., & Quiñones, P. A. (2012). The Skyline TEAMS model: A longitudinal look at the impacts of K-12 engineering on perception, preparation and persistence. *Advances in Engineering Education, 3*(2), 1–25. https://eric.ed.gov/?id=EJ1076117

From the ERIC abstract: "This paper describes the longitudinal impacts of a partnership between the University of Colorado Boulder's K-12 Engineering Education initiative and the St. Vrain Valley School District. Together, university and high school educators created a replicable pre-college engineering model in a nine-school feeder system, which serves many Colorado students who are traditionally underrepresented in the engineering profession, and culminates with a high school STEM (science, technology, engineering, and mathematics) Academy whose graduates are motivated to thrive in engineering colleges. However, the following question, 'Is this an effective model for increasing student STEM persistence and performance?' remains a driver for our investments as we refine the K-12 engineering program based on partner school feedback and quantitative and qualitative assessment results. Data show that our K-12 engineering program has positively impacted student perception, preparedness, and persistence in engineering based on regular, pre-college hands-on engineering design experiences. A description of the multi-year K-12 engineering model and longitudinal analysis of students' concurrent math course choices is presented. Also, subsequent student persistence in and from the STEM Academy is addressed."

Additional Organizations to Consult

Advance CTE: State Leaders Connecting Learning to Work – https://careertech.org/

From the website: "Advance CTE is the longest-standing national non-profit that represents State CTE Directors and state leaders of Career Technical Education. Learn more about our mission, vision and what we do in this section. Advance CTE: State Leaders Connecting Learning to Work, first established in 1920, is the longest-standing national non-profit that represents State CTE Directors and state leaders responsible for secondary, postsecondary and adult Career Technical Education (CTE) across all 50 states, the District of Columbia and U.S. territories. Mission: Support visionary state leadership, cultivate best practices and speak with a collective voice to advance high-quality CTE policies, programs and pathways that ensure career success for each learner. Vision: Transform and expand CTE so that each learner – of any background, age and zip code – is prepared for career and college success through state leadership, advocacy and partnerships."

REL Southwest note: Advance CTE offers a variety of report publications at https://careertech.org/resources/advance-cte-reports

Association for Career & Technical Education® (ACTE®) – https://www.acteonline.org/

> *From the website*: "ACTE is a national association representing thousands of career and technical education professionals, all working to make a real difference in students' lives. We provide educators with powerful resources, professional development, and information to help them achieve more. ACTE's Mission: To provide educational leadership in developing a competitive workforce. ACTE strives to empower educators to deliver high quality CTE programs that ensure all students are positioned for career success."

CTE Research Network – https://cteresearchnetwork.org/

> *From the website*: "Career and technical education (CTE) prepares students with academic, technical, and employability skills for success in the workplace and in further education. Most high school students take at least one CTE course, and postsecondary students commonly pursue credentials in CTE. However, more research is needed to understand the effects of CTE on student outcomes. The CTE Research Network seeks to meet this need by increasing the number of CTE impact studies and strengthening the capacity of the field to conduct and use rigorous CTE research."

Illinois Pathways: Science, Technology, Engineering, and Mathematics – https://www.illinoisworknet.com/ilpathways/Pages/default.aspx

> *From the website*: "Illinois Pathways are an innovative public-private education partnership that is organized to support local implementation of National Career Clusters Framework and Programs of Study by coordinating and reducing the transaction cost among statewide networks of education partners, businesses, industry associations, labor organizations, and other organizations. Select any of the Illinois Pathways below to view information about them. To learn more about Illinois' Unified State Framework for College and Career Readiness and Success check out the Career Pathways Dictionary. View the Illinois State Board of Education's Career Guide for more information about career options."
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> *REL Southwest note*: Illinois Pathways provides the following resource relevant to this request: https://apps.il-work-net.com/cis/Clusters/Occupations/111500

National Science Foundation, STELAR STEM Learning and Research Center – http://stelar.edc.org/

> *From the website*: "The mission of STELAR is to build capacity and magnify the results of ITEST projects to deepen the impact of the ITEST program. To do so, we will focus on three core areas:
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> 1. Technical support that facilitates ITEST projects' success in developing and articulating innovative models for STEM learning environments
> 2. Synthesis and dissemination of ITEST projects' findings nationally in order to inform and influence a national community of other stakeholders

3. Outreach efforts to broaden participation in the ITEST community to individuals from organizations and communities not currently represented in the ITEST portfolio

Since 2003, beginning with the previous ITEST Learning Resource Center (LRC), EDC has provided highly regarded technical assistance to over 326 ITEST projects, shared key ITEST findings through online and print products and events, and established a vibrant ITEST Community of Practice. EDC continues to successfully support this community and leverages social media and advances in technology to enhance STELAR's technical support, dissemination, and outreach."

New York State Department of Education, Multiple Pathways – http://www.nysed.gov/curriculum-instruction/multiple-pathways

From the website: "Multiple pathways recognize the importance of engaging students in rigorous and relevant academic programs. The regulations approved in 2015 and 2016 recognize students' interests in the Arts, Biliteracy (LOTE), Career and Technical Education (CTE), Career Development and Occupational Studies (CDOS), Humanities, and Science, Technology, Engineering and Mathematics (STEM) by allowing an approved pathway to meet the students' graduation requirements.

Under the "4+1" pathway assessment option, students must take and pass four required Regents Exams or Department-Approved Alternative assessments (one in each of the following subjects: English language arts, mathematics, science, and social studies) and complete a comparably rigorous pathway to meet the fifth assessment requirement for graduation."

Skills USA, Inc. – https://www.skillsusa.org/

From the website: "The SkillsUSA Framework illustrates how students fulfill the mission of the organization 'to empower members to become world-class workers, leaders and responsible American citizens.' What it does: Provides a common language for students to articulate what they gain from SkillsUSA participation to employers, school administrators, parents and other students; Assesses student skill development along a learning continuum of awareness, demonstration and mastery; Creates a vision for SkillsUSA programs at the local, state and national levels to ensure quality student-led experiences that build skills in all members. Why it works: Empowers every student to achieve career success; Delivers a skill set demanded by business and industry but lacking in many employees today; Ensures that every student member receives a consistent and specific skill set."

From the SkillsUSA 2019 annual report: "SkillsUSA accelerates growth for students through our SkillsUSA Framework. Framework components include personal skills, workplace skills and technical skills grounded in academics. The Framework builds a foundation for relevant learning and provides a common language to help students, teachers, parents and industry communicate the program's value. The Framework Essential Elements were developed using research from over 1,000 employers and represent the most crucial skills they look for in a successful hire. The Framework is

essential to SkillsUSA's mission because it serves as the blueprint for the ultimate goal of our organization: career readiness."

U.S. Department of Education, Office of Career, Technical, and Adult Education, Division of Academic and Technical Education (CTE.ed.gov) – https://cte.ed.gov/initiatives/about-national-initiatives

From the website: "Congress appropriates roughly $7.4 million annually to support research; development and demonstration; dissemination; and evaluation and assessment activities aimed at improving the quality and effectiveness of career and technical education programs."

REL Southwest note: CTE.ed.gov supports multiple initiatives relevant to this request, including the following:

- Career Pathways Systems at https://cte.ed.gov/initiatives/career-pathways-systems
- CTE Research Network at https://cte.ed.gov/initiatives/cte-research-network
- Supporting Student Success in CTE at https://cte.ed.gov/initiatives/supporting-student-success-in-cte

U.S. Department of Labor, Employment and Training Administration, Workforce Innovation and Opportunity Act (WIOA) – https://www.dol.gov/agencies/eta/wioa/

From the website: "WIOA is landmark legislation that is designed to strengthen and improve our nation's public workforce system and help get Americans, including youth and those with significant barriers to employment, into high-quality jobs and careers and help employers hire and retain skilled workers.

Technical Assistance & Stakeholder Engagement. The U.S. Department of Labor (DOL), in coordination with federal partners the U.S. Departments of Education (ED) and Health and Human Services (HHS), collaborated to provide information and resources for States, local areas, non-profits and other grantees, and other stakeholders to assist with WIOA enactment."

REL Southwest note: WIOA provides the following resource relevant to this request: https://www.dol.gov/sites/dolgov/files/OASP/legacy/files/3-Career-Pathways-Implementation-Synthesis.pdf

Methods

Keywords and Search Strings

The following keywords and search strings were used to search the reference databases and other sources:

- (STEM OR "STEM education") AND (CTE OR "career and technical education" OR "career education" OR "vocational education") AND (pathway OR program)
- (STEM OR CTE OR "career and technical education") AND (pathway OR program) AND ("Environmental Protection" OR "Digital Design" OR "Emergent Media" OR "Pre-Engineering" OR "Engineering" OR "NICERC" OR "Cyber Security" OR "PLTW" OR "Pre-Pharmacy" OR "Pharmacy")

Databases and Resources

We searched ERIC for relevant, peer-reviewed research references. ERIC is a free online library of more than 1.8 million citations of education research sponsored by the Institute of Education Sciences (IES). Additionally, we searched the What Works Clearinghouse.

Reference Search and Selection Criteria

When we were searching and reviewing resources, we considered the following criteria:

- *Date of the publication:* References and resources published from 2005 to present, were included in the search and review.
- *Search priorities of reference sources:* Search priority is given to study reports, briefs, and other documents that are published and/or reviewed by IES and other federal or federally funded organizations, academic databases, including ERIC, EBSCO databases, JSTOR database, PsychInfo, PsychArticle, and Google Scholar.
- *Methodology:* The following methodological priorities/considerations were given in the review and selection of the references: (a) study types—randomized control trials, quasi-experiments, correlational studies, descriptive data analyses, literature reviews, mixed methods analyses, and so forth; (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected, and so forth), study duration, and so forth; and (c) limitations, generalizability of the findings and conclusions, and so forth.

This memorandum is one in a series of quick-turnaround responses to specific questions posed by stakeholders in the Southwest Region (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas), which is served by the Regional Educational Laboratory (REL) Southwest at AIR. This memorandum was prepared by REL Southwest under a contract with the U.S. Department of Education's Institute of Education Sciences (IES), Contract ED-IES-91990018C0002, administered by AIR. Its content does not necessarily reflect the views or policies of IES or the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.